

State of Wisconsin/Department of Transportation
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Sep 30, 2003

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| Program: SPR-0010(36) FFY99 | | Part: II Research and Development | |
| Project Title: Effects of Ground Granulated Blast Furnace Slag in Portland Cement Concrete | | Project ID: 0092-02-14a | |
| Administrative Contact: Nina McLawhorn | | Sponsor: | |
| WisDOT Technical Contact: Error! Bookmark not defined. | | Approved Starting Date: Nov 7, 2001 | |
| Approved by COR/Steering Committee: \$194,251.00 | | Approved Ending Date: Dec 31, 2003 | |
| Project Investigator (agency & contact): Steve Cramer: UW-Madison | | | |

Description: Federal transportation directives encourage the use of by-product materials and mandate open and unrestricted competition for alternative cementitious materials. In 1995, the EPA listed ground granulated blast furnace slag (GGBFS) as a recyclable material in the Federal Register. GGBFS is a cementitious materials that replaces a portion of the portland cement in a concrete mix and is being used with increasing frequency for pavement in concrete in Wisconsin.

The production and use of GGBFS is more than 100 years old, yet significant levels of use in Wisconsin are quite recent. GGBFS is manufactured across the world but recently has been offered in Wisconsin by only one manufacturer.

Relevant questions associated with GGBFS use for Wisconsin include: 1) what replacement level of cement is most appropriate and what are the performance tradeoffs with different levels?

2) How do the fineness and activation characteristics vary from shipment to shipment of GGBFS among shipments of the current primary supplier and those of other new suppliers planning product introduction in 2001?

3) How does the GGBFS effect performance, change with different cement chemical compositions?

4) Are there undesirable interactions with admixtures or other additives?

| Total Study Budget | Current FFY Budget | Expenditures for Current Quarter | Total Expenditures to Date | Percent Complete |
|---------------------------|---------------------------|---|-----------------------------------|-------------------------|
| \$194,251.00 | \$64,750.33 | \$11,869.65 | \$47,113.66 | 67 (%) |

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Progress This Quarter:

(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

Progress this quarter included:

- 1) Preparation of 15 concrete mixtures as part of Task 3 (Strength gain and air void development with different cements, air entraining admixtures and temperatures)
- 2) Cylinder compression tests for all Task 3 limestone aggregate mixtures have been completed through 56 days. This amounts to approximately 60 compression cylinder tests. Cylinder compression tests for Task 3 mixtures containing igneous aggregates have commenced and are in progress.
- 3) Approximately 30 shrinkage specimens are being monitored in 50%RH controlled environment for air dry shrinkage. Due to lack of conditioning space at the university some shrinkage specimens were relocated to the WisDOT materials lab at Kinsman Blvd.
- 4) A new graduate student joined the research team in mid-June. IN June and early July he was trained on the various aspects of the project and preparing concrete specimens for research.
- 5) The research team received training for the Blaine fineness test at the WisDOT materials lab and this test is now being conducted as part of the research.
- 6) A sample of GGBFS has been obtained from a local ready mix supplier each month for monitoring the variability of GGBFS coming into Wisconsin. Activation tests have been conducted for all monthly samples starting with august 2002 and ending with August 2003. Each slag-cement mortar cube was compared to the average strength of three cement mortar cubes made on the same day. The individual activity indexes were averaged and this average was recorded as the slag activity index for each month. The slag activity index was calculated for 7-day and 28-day strengths.
- 7) The research team met approximately four times during the quarter.

Work Next Quarter:

The goals for next quarter are to complete Task 3, choose a cement to complete Task 4 (deicer scaling tests), and commence concrete mixing to complete Task 4.

Circumstances affecting progress/budget:

A second graduate student joined the research team and progress accelerated on the project. None-the-less, the project is a couple hundred days behind schedule and a no-cost extension will be requested.

Gantt Chart:

| ID | Task Name | Duration | Start | Finish | 2002 | | | | 2003 | | | | 2004 | | | | 2005 | | | | 2006 |
|----|--|----------|--------------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| | | | | | Qtr 2 | Qtr 3 | Qtr 4 | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Qtr 1 | |
| 1 | Project Status | 525 days | Tue 1/15/02 | Mon 1/19/04 | | | | 67% | | | | | | | | | | | | | |
| 2 | Task I | 85 days | Tue 1/15/02 | Mon 5/13/02 | | | | | | | | | | | | | | | | | |
| 3 | Update literature study | 40 days | Tue 1/15/02 | Mon 3/11/02 | | | | 80% | | | | | | | | | | | | | |
| 4 | Survey and document regional experiences | 70 days | Tue 1/15/02 | Mon 4/22/02 | | | | 80% | | | | | | | | | | | | | |
| 5 | Re-examine & finalize study plan | 62 days | Fri 2/15/02 | Mon 5/13/02 | | | | 100% | | | | | | | | | | | | | |
| 6 | Task 2: Monitor GGBFS Variability | 470 days | Tue 2/12/02 | Mon 12/1/03 | | | | 72% | | | | | | | | | | | | | |
| 7 | Obtain GGBFS samples | 460 days | Tue 2/12/02 | Mon 11/17/03 | | | | 90% | | | | | | | | | | | | | |
| 8 | Send out for fineness and chemical tests | 460 days | Thu 2/21/02 | Wed 11/26/03 | | | | 45% | | | | | | | | | | | | | |
| 9 | Conduct activation tests | 460 days | Tue 2/26/02 | Mon 12/1/03 | | | | 80% | | | | | | | | | | | | | |
| 10 | Task 3: Strength & Air Void Development | 299 days | Tue 4/2/02 | Fri 5/23/03 | | | | 56% | | | | | | | | | | | | | |
| 11 | Obtain materials | 50 days | Tue 4/2/02 | Mon 6/10/02 | | | | 85% | | | | | | | | | | | | | |
| 12 | Prepare and check mix designs | 10 days | Wed 6/5/02 | Tue 6/18/02 | | | | 70% | | | | | | | | | | | | | |
| 13 | Prepare specimens | 100 days | Thu 6/20/02 | Wed 11/6/02 | | | | 65% | | | | | | | | | | | | | |
| 14 | Curing and testing | 200 days | Mon 7/8/02 | Fri 4/11/03 | | | | 65% | | | | | | | | | | | | | |
| 15 | Air void tests | 100 days | Fri 7/26/02 | Thu 12/12/02 | | | | 25% | | | | | | | | | | | | | |
| 16 | Analyze results | 30 days | Mon 4/14/02 | Fri 5/23/03 | | | | | | | | | | | | 10% | | | | | |
| 17 | Task 4: Deicer scaling tests | 210 days | Mon 9/2/02 | Fri 6/20/03 | | | | 57% | | | | | | | | | | | | | |
| 18 | Scaling tests - series 1 | 100 days | Mon 9/2/02 | Fri 1/17/03 | | | | 100% | | | | | | | | | | | | | |
| 19 | Scaling tests - series 2 | 100 days | Mon 9/30/02 | Fri 2/14/03 | | | | 100% | | | | | | | | | | | | | |
| 20 | Scaling tests - series 3 | 100 days | Mon 2/3/03 | Fri 6/20/03 | | | | | | | | | | | | 0% | | | | | |
| 21 | Scaling tests - series 4 | 26 days | Mon 3/3/03 | Mon 4/7/03 | | | | | | | | | | | | 0% | | | | | |
| 22 | Analyze results | 26 days | Mon 2/17/02 | Mon 3/24/03 | | | | | | | | | | | | 0% | | | | | |
| 23 | Reporting | 510 days | Tue 2/5/02 | Mon 1/19/04 | | | | 68% | | | | | | | | | | | | | |
| 24 | Interim Quarterly Reports | 510 days | Tue 2/5/02 | Mon 1/19/04 | | | | 85% | | | | | | | | | | | | | |
| 25 | Prepare interim report & TOC meeting | 10 days | Mon 4/29/02 | Fri 5/10/02 | | | | 0% | | | | | | | | | | | | | |
| 26 | TOC Meeting #1 | 2 days | Mon 5/27/02 | Tue 5/28/02 | | | | 0% | | | | | | | | | | | | | |
| 27 | TOC Meeting #2 | 2 days | Mon 6/9/02 | Tue 6/10/02 | | | | | | | | | | | | 0% | | | | | |
| 28 | Prepare draft final report | 40 days | Wed 6/11/02 | Tue 8/5/03 | | | | | | | | | | | | 0% | | | | | |
| 29 | Review/Revise/Submit final report | 50 days | Wed 8/6/02 | Tue 10/14/03 | | | | | | | | | | | | 0% | | | | | |
| 30 | Contingency | 25 days | Wed 10/15/02 | Tue 11/18/02 | | | | | | | | | | | | 0% | | | | | |

Note: Gantt chart shown in State Fiscal Year Quarters